

CLAIMS

What is claimed:

1. A quantitative method for measuring tissue movement comprising:
 - 5 providing a Doppler imaging system;
 - forming a B-mode reference image of moving tissue;
 - forming a gate defining a region of interest of the tissue;
 - forming pulsed wave spectral tissue Doppler data of the region of interest;

and

 - 10 determining displacement of the tissue within the region of interest.
2. The method of Claim 1 further comprising forming a tissue Doppler image of the tissue, and forming the gate using the tissue Doppler image.
- 15 3. The method of Claim 1 further comprising measuring displacement of a septal wall and lateral free wall of a heart as a function of time for at least a cardiac cycle.
4. The method of Claim 1 further comprising displaying simultaneously
20 displacement of a septal wall and lateral wall of a heart as a function of time for at least a cardiac cycle.
5. The method of Claim 1 wherein the step of forming the gate comprises forming at least two pulsed wave spectral Doppler lines in a single image frame to define the
25 region of interest.
6. The method of Claim 5 wherein the step of forming the gate comprises forming multiple-gates on each spectral Doppler line to define the region of interest..

7. The method of Claim 1 wherein the first region comprises a septal wall of a heart and the second region comprises a lateral wall of the heart.
8. The method of Claim 6 further comprising using automatic boarder detection to measure tissue movement.
5
9. The method of Claim 1 further comprising triggering image capture using an EKG.
10. The method of Claim 1 further comprising determining a directional value to indicate a direction of tissue displacement.
10
11. The method of Claim 1 further comprising providing an apical image of a heart with at least a 2-chamber view.
15
12. The method of Claim 1 further comprising providing a short axis view of a heart.
13. The method of Claim 1 further comprising determining a strain rate of tissue within the region of interest.
15
14. The method of Claim 6 further comprising averaging the multiple-gate to detect global displacement of a septal wall of a heart and global displacement of a left free wall of a heart.
20
15. The method of Claim 1 further comprising time integrating the pulsed wave spectral tissue Doppler data to determine displacement of tissue within the region of interest.
25

16. The method of Claim 14 further comprising measuring dysynchronous ventricular movement of the heart.
17. The method of Claim 12 further comprising displaying a B-mode image and simultaneously displaying displacement of an interventricular septal wall and a left free wall of a heart as a function of time for at least a cardiac cycle to visualize dysynchronous ventricular movement of the heart.
5
18. The method of claim 12 further comprising gold standard image set to guide the echocardiography imaging operations and to facilitate obtaining the quantitative data representative of heart wall motion.
10
19. A quantitative method for measuring tissue movement comprising:
15 providing an echocardiography imaging system;
 forming a sequence of B-mode reference images of moving tissue;
 using automatic border detection to detect tissue movement; and
 determining displacement of the tissue within the region of interest.
20. The method of Claim 19 wherein the step of using automatic border detection further comprises using a B-mode image and a motion compensated block searching process, each block comprising a plurality of pixels of the image.
20
21. The method of Claim 20 wherein each block has a size in a range of 3 X 3 pixels to 31 X 31 pixels.
25
22. The method of Claim 20 wherein the step of using automatic border detection further comprises providing an intensity threshold sequence to determine wall tissue boundaries.

23. The method of Claim 20 further comprising determining an intensity value by summing an intensity of each pixel in a block.
- 5 24. The method of Claim 19 further comprising simultaneously measuring displacement of a septal wall and a left free wall of a heart as a function of time for at least one cardiac cycle.
- 10 25. The method of claim 19 further comprising determining phase angle of displacement of a septal wall and a left wall of a heart, determining relative delay movement between the septal wall and the left wall of the heart.
26. The method of Claim 19 wherein B-mode image capturing is EKG triggered.
- 15 27. The method of Claim 19 further comprising setting at least 5 anchor points on an image of a heart to define a search area for block matching.
- 20 28. A method for providing operating parameters for a biventricular pacemaker comprising:
 - performing an echocardiographic imaging process to provide quantitative data representative of heart wall motion; and
 - selecting lead delay settings for a biventricular pacemaker using the quantitative data.
- 25 29. The method of Claim 28 wherein the step of performing a Doppler imaging process includes forming a plurality of gates in a single image frame for the measurement of the lateral wall and septal wall of a heart.

30. The method of Claim 28 further comprising forming pulsed wave spectral tissue Doppler data of the lateral wall and the septal wall.
31. The method of Claim 28 wherein capture of the echocardiographic image is EKG triggered.
5
32. The method of Claim 28 wherein the gates are formed using a plurality of spectral Doppler lines on single image frame of the heart.
- 10 33. The method of Claim 28 further comprising determining phase angle of displacement of an interventricular septal wall and a left free wall of a heart, determining relative delay movement between the two walls.
- 15 34. The method of Claim 28 further comprising performing a phase analysis of heart wall motion using automatic border tracking.
- 20 35. A system for diagnostic imaging of moving tissue comprising:
an ultrasound image display; and
a processing system, including a processing sequence stored on a computer readable medium, the processing sequence utilizing pulsed wave spectral Doppler data of moving tissue within gates of an image frame that determine a displacement of tissue.
- 25 36. The system of Claim 35 further comprising a programming processor connected to the processing system that programs a pacemaker.
37. The system of Claim 35 further comprising a Doppler processor.

-30-

38. The system of Claim 35 wherein the processing sequence further comprises spectral lines defining gates within an image frame.

39. The system of Claim 35 further comprising an external ultrasound probe.

5

40. The system of Claim 35 further comprising an ultrasound probe insertable within a body lumen.